SAND PLAINS RESEARCH FARM

SOILS REPORT 1988

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SOIL CONSERVATION SERVICE
INTRODUCTION

The purpose of this report is to provide researchers with additional information about the soils on the Sand Plains Research Farm.

In 1986, a soil survey of the Sand Plains Research Farm was done by Allan G. Giencke of the Soil Conservation Service (Map 1, pp 6-13). In addition to the mapping of the different soil types, the Agricultural Engineering Department provided information on the available water holding capacity, topography, bulk density, and soil compaction.

This information should be useful to anyone currently conducting research on the farm or planning to in the future. It will enable researchers to lay out their plots in areas that contain the most uniform soils, eliminating some of the problems soil variability presents in the analysis of field data.

AVAILABLE WATER CAPACITY (AWC)

The field capacity for the four different soil types was determined by the in-situ method outlined in Method of Soil Analysis Part 1 (Procedure 36-2.1.3). The field data was collected in October 1986, when no vegetation was present to affect the soil drainage. The wilting point was determined using the pressure plate apparatus at fifteen bars pressure. Available water capacity (AWC) was defined as:

\[
AWC \text{ (inches)} = \frac{\% \text{ MC (1.0 bars)} - \% \text{ MC (15 bars)} \times \text{ inches of soil depth}}{100}
\]

Nine sites were chosen in each of the four soil types. The available water capacity was determined in three inch increments, to a depth of three feet (pp.15 Table I). Statistical analysis revealed no significant differences between soil types below one foot (pp.16 Table II). Closer examination of the top foot indicates that soil types 1 and 4 are the only soils not significantly different from each other (pp.17 Table III).
TOPOGRAPHIC SURVEY

A topographic map of the farm (pp.19-20 Map 2), was completed in the Spring of 1987. Since the soil types on the farm are differentiated mostly by local relief, the topographic map may better depict the boundaries between soil types. This is especially true for soil types 1, 2, and 3, where the local relief is the greatest. Soil type 4 shows up well on the topographic map as small areas of depression. Where soil type 4 follows old stream channels, the relief between it and soil type 1 is not great enough to show on the topographic map.

The soil map was traced on the topographic map and enlarged into eight sections covering the entire farm (pp. 21-28 Maps 3-11).

PENETROMETER

Previous research done at the Sand Plains Research Farm, by Jonathan Chaplin from Agricultural Engineering, indicated a presence of a compacted soil layer (Chaplin, Lueders and Rugg, 1986). Chaplin did his work in 1984 using a cone penetrometer on tillage research plots. Chaplin discovered a compacted layer with a mean cone index of 2200 kPa at a depth of 24 cm for all of the tillage plots tested except the chisel plow treatment. The accepted range of soil compaction before root penetration is inhibited is 2000 - 2500 kPa (Taylor, 1963; Taylor, 1968; and Voorhees, 1975).

In the fall of 1987, soil compaction was measured in all of the fields currently being used for research. A grid was laid out to determine the location of each test site, using the existing 200 ft marker posts in the north-south direction and laying out 100 ft stakes in the east-west direction. The data was taken using the same tractor mounted penetrometer, proving ring, data logger and cone penetrometer that Chaplin used. All the holes were punched on the same day. Graphs 1 - 9 (pp.29-37) show the average mean cone index versus the depth for the fields tested.
The average mean cone index for each field starts to exceed the 2000 - 2500 kPa range between 20 - 25 cm, then peaks between 25 - 35 cm and drops off again after 35 cm.

The average bulk density measurements are shown in Table IV, pp 18.

**CONCLUSION**

Comparing the soils map with the research plot layout on the Sand Plains Research Farm, it's apparent that a good job has already been done in picking out the best research fields. The research plots are laid out in the most level areas, avoiding the ridge of Nymore loamy sand that runs from northwest to southeast across the center of the farm.

On an individual plot basis, researchers should be aware that many of their plots include at least two and sometimes three different soil types. Identifying the different soil types is not difficult. It can be done simply by observing the topographical differences in the field and referring back to the soils map. The spring and fall are the best times because the lack of vegetation makes the entire field visible.

The main effect different soil types will have on research is the differences in the available water capacity in the top foot. These differences will affect the scheduling of irrigation. The Hubbard loamy sand (1.67 in) and the Hubbard-Nymore loamy sand (1.33 in) are the two predominant soils occurring in the research areas. Unless the research plot being irrigated is entirely within one soil type, a decision will have to be made as to which value of available water to use for irrigation scheduling. If scheduling is based on Hubbard loamy sand (1.67 in), the Hubbard-Nymore soil will drop below the 50% depletion level on an average of 12 - 24 hours per irrigation period. If the Hubbard-Nymore value (1.33 in) is used for irrigation scheduling, the Hubbard loamy sand will be over irrigated, resulting in possible nutrient leaching and higher irrigation costs. An average value of the two soils might be considered.
Other factors affecting irrigation scheduling would be the percent of Hubbard loamy sand or Hubbard-Nymore loamy sand existing in a particular plot and the capabilities of the irrigation system on the farm.

The penetrometer data raised more questions than it answered. The graphs definitely show a hard layer at approximately the same depth in all the fields on the farm. The resistance to penetration of this layer is above the level through which plant roots can easily penetrate. It's beyond the scope of this data to determine if the hard layer is related to soil type, tillage practices, or is the result of an alluvial deposit. Chaplin (1986) observed that deep chiseling broke up the hard layer and that plants grew more rapidly on chisel plowed plots than plots that hadn't been chisel plowed. However, no differences in the final yields were observed. Agricultural Engineering is considering doing more research on this hard layer to determine what it is caused by and what effect it might have on plant growth.

The differences that exist on the farm between soil types, available water capacity, and the resistance to penetration of roots are factors that researchers might want to consider in their research at the Sand Plains Research Farm. Hopefully the data in this report will be useful to researchers and farm personnel in determining what affect these differences will have on their particular research and assist in improving the result of their projects.

I would like to thank Nancy Johnson, Glenn Titrud, Bill Connelly and John Fick for their assistance in preparing this report.
Soils on Sand Plains Research Farm
Becker, Minnesota
by Allan G. Giencke
USDA - SCS
January 26, 1987

INTRODUCTION

During May of 1986, soil scientist Allan G. Giencke of the Soil Conservation Service conducted a detailed mapping of the Sand Plains Research Farm.

The mapping was done on an ASCS 1957 base map with a scale of about 12.25 inches to the mile. This photo base was selected because it displayed better soil patterns than other sources of aerial photographs. It's disadvantage is the lack of current cultural features to locate oneself on the photo. It would be desireable to transfer the soil boundaries to a current photo base.

Soil borings were taken to a depth of 60 inches with a truck mounted Giddings power probe in areas where access was no problem. In other area, a JMC backsaver hand auger was used.

LEGEND

There were four map units recognized on the Research Farm. They included the following:

1. Hubbard loamy sand, 0 to 1 percent slopes.
2. Hubbard-Nymore loamy sands, 1 to 3 percent slopes.
3. Nymore loamy sand, 2 to 5 percent slopes.
4. Sverdrup sandy loam, 0 to 1 percent slopes.
CLASSIFICATION

<table>
<thead>
<tr>
<th>Series</th>
<th>Classification</th>
</tr>
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<tbody>
<tr>
<td>Hubbard</td>
<td>Udorthentic Haploboroll, sandy, mixed</td>
</tr>
<tr>
<td>Nymore</td>
<td>Typic Udipsamment, frigid, mixed</td>
</tr>
<tr>
<td>Sverdrup</td>
<td>Udic Haploboroll, sandy, mixed</td>
</tr>
</tbody>
</table>

LANDSCAPE POSITION

The following schematic drawing represents the approximate landscape position for the four map units.

```
    Hubbard  Sverdrup  Nymore  Hubbard  Hubbard-Nymore Complex
        |            |          |            |                      |
```

The local relief between map units 1, 2, and 4 is typically 1 to 3 feet. Map unit 3 has a stronger relief of about 3 to 8 feet.

SERIES DESCRIPTIONS

Hubbard Series

1490 feet east and 1630 feet north of the SW corner of sec. 36, T134N, R29W.

Ap-- 0 to 8 inches; black (10YR 2/1) loamy sand, dark grayish brown (10YR
4/2) dry; weak medium subangular blocky structure; very friable; 1 percent coarse fragments; medium acid; abrupt smooth boundary.

A-- 8 to 13 inches; very dark brown (7.5YR 2/2) loamy sand, dark brown (7.5YR 4/2) dry; weak medium subangular blocky structure; very friable; 1 percent coarse fragments; slightly acid; clear wavy boundary.

Bw-- 13 to 19 inches; dark brown (7.5YR 3/4) loamy coarse sand; weak fine subangular blocky structure; very friable; 1 percent coarse fragments; slightly acid; clear wavy boundary.

BC-- 19 to 34 inches; dark brown (7.5YR 4/4) coarse sand; single grain; loose; 2 percent coarse fragments; slightly acid; clear wavy boundary.

C-- dark yellowish brown (10YR 4/4) coarse sand; single grain; loose; 5 percent coarse fragments; neutral.

Range in Characteristics

The thickness of solum ranges from 25 to 50 inches. Depth to free carbonates ranges from 40 to over 60 inches. The mollic epipedon is 10 to 26 inches thick. Coarse fragments make 0 to 10 percent of the solum and C horizon.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is typically loamy sand or loamy coarse sand, but includes sand or sandy loam. It is medium acid through neutral.

The Bw horizon has hue of 10YR and 7.5YR, value of 3 through 5, and chroma of 2 through 4. It is loamy sand, loamy coarse sand, sand, or coarse sand. It is medium acid through neutral.

The BC horizon is similar to the B horizon but lacks textures of loamy sand or loamy coarse sand.
The C horizon has hue of 10YR or 7.5YR, value of 4 through 6, and chroma of 3 through 5. It is sand or coarse sand. It is slightly acid or neutral.

Nymore Series

900 feet west and 2260 feet north of the SE corner of sec. 36, T134N, R29W.

AP-- 0 to 8 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.

Bw1-- 8 to 15 inches; dark brown (7.5YR 3/4) sand; single grain; loose; slightly acid; clear wavy boundary.

Bw2-- 15 to 34 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; slightly acid; clear wavy boundary.

C-- 34 to 60 inches; brown (10YR 5/3) sand; single grain; loose; slightly acid.

Range in Characteristics

The thickness of solum ranges from 25 to 45 inches. Depth to free carbonates ranges from 48 to over 60 inches. Coarse fragments comprise 0 to 10 percent of the solum and C horizon.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 through 3. It is typically loamy sand or loamy coarse sand, but includes sand or coarse sand. Reaction is medium acid through neutral.

The B horizon has hue of 10YR of 7.5YR, value of 3 or 4, and chroma of 3 or
4. It is typically sand or coarse sand. It is medium acid through neutral.

The C horizon has hue of 10YR or 7.5YR, value of 5 through 7, and chroma of 2 through 6. It is sand or coarse sand. The reaction is slightly acid or neutral.

Sverdrup Series

155 feet east and 780 feet north of the SW corner of sec. 31, T134N, R28W.

Ap-- 0 to 9 inches; black (10YR 2/1) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; very friable; slightly acid; abrupt smooth boundary.

A-- 9 to 12 inches; very dark brown (7.5YR 2/2) sandy loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; very friable; about 1 percent coarse fragments; slightly acid; gradual wavy boundary.

Bw1-- 12 to 16 inches; 50 percent dark brown (7.5YR 4/2) and 50 percent dark brown (7.5YR 4/2) sandy loam; weak fine subangular blocky structure; very friable; about 1 percent coarse fragments; slightly acid; clear wavy boundary.

Bw2-- 16 to 20 inches; dark brown (7.5YR 4/4) loamy sand; weak fine subangular blocky structure; very friable; about 3 percent coarse fragments; slightly acid; clear wavy boundary.

BC-- 20 to 41 inches; dark brown (7.5YR 4/4) sand; single grain; loose; about 4 percent coarse fragments; slightly acid; clear wavy boundary.

C-- 41 to 60 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; about 5 percent coarse fragments; neutral.
Range in Characteristics

The thickness of solum ranges from 30 to over 60 inches. Free carbonates are typically at a depth of 48 to over 60 inches. The mollic epipedon ranges from 10 to 16 inches in thickness. Coarse fragments make up 0 to 10 percent of the solum and C horizon.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is typically sandy loam but includes loam and fine sandy loam. The reaction is medium acid through neutral.

The Bw horizon has hue of 10YR to 7.5YR, value of 3 through 5, and chroma of 2 through 4. It is typically sandy loam or loam in the upper part that grades to loamy sand or loamy coarse sand with depth. It is medium acid through neutral.

The BC horizon has hue of 10YR or 7.5YR, value of 4 through 6, and chroma of 3 or 4. It is sand or coarse sand. Reaction is medium acid through neutral.

The C horizon has hue of 10YR of 2.5Y, value of 4 through 6, and chroma of 2 through 4. It is sand or coarse sand. Reaction is slightly acid or neutral.

MAP UNIT DESCRIPTIONS

1. Hubbard loamy sand, 0 to 1 percent slopes.

This deep excessively drained, nearly level soil typically occurs on plain slopes with gradients of 1 percent or less. It formed in medium to coarse textured outwash sediment.

The permeability is rapid. The surface runoff is slow. The available water capacity is low and the organic matter content is low to medium.
Included in this map unit are small areas of Nymore on slight convex rises and small areas of Sverdrup soils in concave swales and depressions. Also, in places, the underlying material has thin layers of gravel.

2. Hubbard-Nymore loamy sands, 1 to 3 percent slopes.

This gently sloping complex consists of about 60 percent excessively drained Hubbard soils and 40 percent excessively drained Nymore soils. Hubbard soils typically occur on plain slopes and Nymore soil typically occur on the most sloping convex areas. Both soils formed in medium to coarse textures outwash sediment.

Both soils in this map unit have rapid permeability. The surface runoff is slow. The available water capacity of both soils is low. Hubbard soils have low to medium organic matter and Nymore soils have low organic matter content.

Included in mapping are small areas of Sverdrup soils in concave swales and toeslopes.

3. Nymore loamy sand, 2 to 5 percent slopes.

This deep gently sloping, excessively drained soil typically occurs on convex ridges and knolls. It formed in medium to coarse textured outwash sediment.

The permeability is rapid. The surface runoff is slow. The available water capacity is low and the organic matter content is low.

Included in this map unit are small areas of Hubbard soils on plain slopes and Sverdrup soils on toeslopes and swales. Also, in places, the underlying material has bands of gravel or contains free carbonates above the depth of 48 inches.

4. Sverdrup sandy loam, 0 to 1 percent slopes.
This deep, well drained, nearly level soil occurs in concave swales and toeslopes. It formed in a thin loamy mantle that overlies medium and coarse textured outwash sediment.

The permeability is moderately rapid and the surface runoff is slow. Occasionally brief ponding may occur during heavy rainfalls. The available water capacity is medium and the organic matter content is high.

Included in mapping are small area of Hubbard soils on plain slopes. Also, in places, the mollic epipedon is thicker. In places, the underlying material has bands of gravel.
REFERENCES


Table I

AVERAGE AVAILABLE WATER (IN)

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<tr>
<th>DEPTH (IN)</th>
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<th>SOIL 3</th>
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<td>0.15</td>
<td>0.20</td>
<td>0.18</td>
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TOTAL AVAILABLE WATER PER FOOT (IN)

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<th>SOIL 3</th>
<th>SOIL 4</th>
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Table II

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<td>.18 (4)</td>
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Any two means not underscored by the same line are significantly different; any two underscored by the same line are not significantly different.
Table III

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<td>3</td>
<td>1.07 (3) 1.19 (2) 1.64 (1) 1.69 (4)</td>
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Any two means not underscored by the same line are significantly different; any two means underscored by the same line are not significantly different.
Table IV

**BULK DENSITY** (g/cm³)

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SOIL PENETROMETER

FIELD 1 BECKER

AVERAGE MEAN CONE INDEX (kPa)
(Thousands)

DEPTH (cm)
SOIL PENETROMETER

FIELD 2 BECKER

AVERAGE MEAN CONE INDEX (kPa)
(Thousands)

DEPTH (cm)
SOIL PENETROMETER

FIELD 6 BECKER

AVERAGE MEAN CONE INDEX (kPa) (Thousands)

DEPTH (cm)
SOIL PENETROMETER

FIELD 7  BECKER

AVERAGE MEAN CONE INDEX (kPa)
(Thousands)

DEPTH (cm)

3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0

5
15
25
35
45
55
SOIL PENETROMETER

FIELD 9 BECKER

AVERAGE CONE INDEX (kPa) (Thousands)

DEPTH (cm)
SOIL PENETROMETER

FIELD 11 BECKER

AVERAGE MEAN CONE INDEX (kPa) (Thousands)

DEPTH (cm)
SOIL PENETROMETER

FIELD 19 BECKER

AVG. CONE INDEX (kPa)
(Thousands)

DEPTH (cm)